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APPLICATION SILICON DOPED WITH ERBIUM IN OPTOELECTRONICS

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In connection with the search for new semiconductor materials that are stable under the influence of heat and resistant to various radiation, interest in the study of the state of rare earth elements (REE) in silicon has recently increased.

One of the current issues in semiconductor electronics is the development of optoelectronic devices based on the use of silicon luminescent structures. It is known that pure monocrystalline silicon is a non-zonal semiconductor material that prevents effective, inter-zonal irradiated recombination. One way to create silicon-based light-emitting structures is to incorporate unique earth elements into it.

In 1983 and 1985, photoluminescence and electrolyuminescence were successfully observed for the first time at a temperature of 77 K based on the reaction of the rare earth element Er to Si [1,2]. The development of Si <Er> structural light emitting elements and the widespread use of devices based on them in optoelectronics is one of the promising areas of scientific research.

The aim of the research is to develop technology and study the electrophysical and optical properties of silicon alloyed with erbium, which is a new material for optoelectronics.

Si samples of n- and p-types were formed by the Czochralski method in the crystallographic directions (100) and (111), as well as in samples with a specific resistance of 1-20 Ohm·cm. The introduction of Er into Si was carried out by the diffusion method, in diffusion furnaces at an temperature of 800-1250 ^{o}C in an inert gas environment.

Structural defects were explored by X-ray diffraction (Empyrean Malvern PANalytical L.T.D) method. The distribution profiles of the electrically active centers were measured using the methods of differential conductivity and voltfarad characteristics. The photoconductivity method was used to determine the activation energy and concentration of electrically active centers in Si <Er> samples.

Luminescence was measured at temperatures of 77–300 K. A halogen lamp with a wavelength of 514.5 nm served as a source of excitation of photoluminescence. The spectra were recorded according to the IKS-21, synchronous detection scheme. Ge- and InGaAs-photodiodes are used as photodetectors.

In the formation of defects at high temperatures, the specific point defects of the silicon lattice begin to play a significant role, so it is advisable to compare the structural defects, the experimental results obtained by studying the electrical and optical active centers in alloyed silicon with the dose and diffusion temperatures.

Unlike oxygen-containing thermodonors, Erbium-containing donors are characterized by a single ionization energy. Significant concentrations of thermodonors forming shallow energy levels only lead to an increase in the temperature of the sample introduced by the serum to 900 oC, and a decrease in the concentrations of the O-type donors and the erbi-center centers. After annealing at 1200 ^{o}C, other donor centers were formed.

Experimental data show that it is the latter centers involved in the transfer of energy to Er^{3+} ions. We observed their formation for the first time at a concentration equal to the total concentration of electrically active centers.

The results of the presented research allowed to lay the foundations of defect engineering in the technology of light-emitting structures based on monocrystalline silicon, alloyed with erbium ions. A method for obtaining Si<Er,O> light-emitting structures by solid-phase epitaxial recrystallization of silicon layers by diffusion of earth ions to the Si base was proposed. Si<Er,O> The temperature-dependent condensation effect of electrolyuminescence intensity on p-n-junctions was determined.

References

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